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DATA-DRIVEN MODELLING AND SIMULATION FOR INTEGRATION OF PRODUCTION PLANNING AND SIMULATION SYSTEMS

Abstract: In the paper production planning and simulation systems integration has been presented. The integration process is executed using the method of data-driven modelling. The process of automatic generation of simulation models is realized in two stages - data mapping to indirect data model and data transformation from this data model to the code of the simulation system internal programming language. In the process of data-driven modelling XML, XML and XSLT Transformation languages are used. The result of transformation is the input file for simulation systems, containing information about the model of production system, together with control procedures.

1. Introduction

Currently, manufacturing enterprises operate in a very dynamic and competitive environment. Market requires to quickly adapt to new circumstances (short lead-time, short product life-cycle, quick response to constantly changing customer requirements, increasing number of product versions) and to invest in an innovative technologies, which are a response to the challenges of the global competition. These demands are forcing manufacturers to look for more effective and efficient methods of production planning and control, especially at the operational level.

One of the possibilities for improving efficiency in the area related to decision support systems for production planning is to integrate planning and discrete-event simulation systems (simulation based production planning and control). Application of discrete-event simulation systems allows quick virtual verification, optimization and validation of developed plans for the sequencing of production orders, buffers capacity, breakdowns of manufacturing resources and information about the specifications of the production system.

Typically, simulation has been applied as a tool for design, analysis and verification of new or reconfigured manufacturing systems [1, 5]. This paper presents the application of simulation in production planning area at the operational level. This approach requires preparing a high level of production system detail in preparation of simulation model and it is very time-consuming and requires more effort and expert knowledge. To cope with these

issues, a data-driven simulation modelling for integration of planning and simulation systems has been proposed.

2. Data-driven modelling and simulation

The concept of data-driven modelling and simulation has been presented in the scientific literature for many years. Data driven modelling and simulation is defined as a method of creating simulation models by users without (or with a minimal) modelling knowledge and without any programming skills [2, 3, 4]. This means that the user of the planning system, which is supported by the simulation system, should be able to prepare simulation models and to perform simulation experiments only by changing the input data to make the necessary changes in the simulation model.

The proposals and research papers meet some basic solutions applied in data-driven modelling [1, 2, 3, 4]:

- Automatic generation of simulation models from the level of the planning system - automatic code generator of simulation models is prepared, dedicated to a specific support planning system and specific simulation system.
- Automatic generation of simulation models for the data collected in a dedicated database (obtained either automatically or manually entered into the database). Stand-alone software modules or modules implemented in the simulation systems generate a simulation model based on the data from the database.
- Te use of structural languages to describe the data required in the process of creating simulation models and using data transformation modules to create a model for a dedicated simulation system.

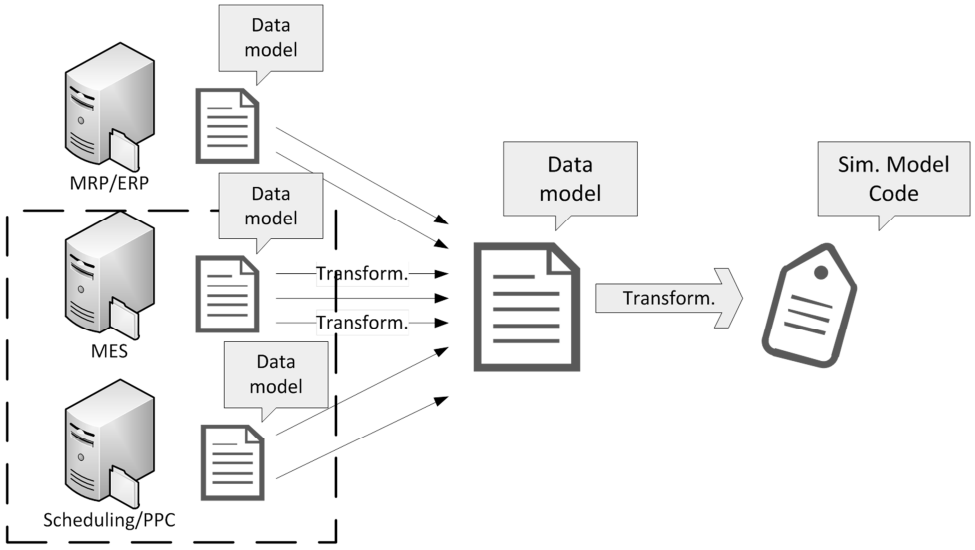

Fig.1. Data-driven modelling concept

In this paper a method of models creation based on the data mapping and data transformation methods has been proposed [6, 7]. The concept of the data-driven modelling, proposed by the author of this paper, is based on the automatic code of simulation models

generation for commercial simulation systems, a combination of data mapping and data transformation methods. The process of creating the simulation model (code of internal programming language of the simulation system) is composed of two consecutive stages (Fig. 1):

- Data mapping between the data model from the input system (production planning support system in the enterprise) and the indirect data model (which is a "standard" definition of the data structure).
- The transformation of data from indirect data model directly into the simulation model code.

The output code contains several kinds of information - including information about the manufacturing system layout, routing of manufacturing processes with setup and cycle time, inter-resources buffers capacity and information about the control procedures for each manufacturing resource and manufacturing processes. By loading the programme code directly into the simulation system, the model is being automatically created and ready to carry out simulation experiments. Any experience is not required for this purpose in construction of simulation models.

3. **Integration of production planning and simulation systems**

Presented in the previous section, the concept of the automatic (and rapid) creation of simulation models became the basis of the method of production planning support systems and simulation systems integration.

Execution of data mapping and data transformation processes was performed based on Extensible Markup Language (XML) and Extensible Stylesheet Language Transformations XSLT application. The corresponding data models are defined using XML Schema, which allows to define restrictions on the mapped data to create new definitions of the data structure, and to combine information from different schemas (sources).

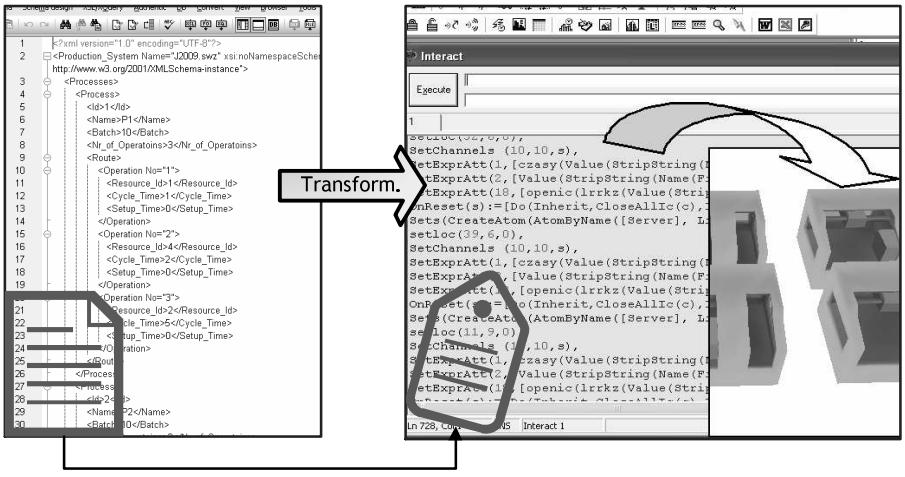

Fig.2. Data model and simulations model code after transformation

The transformation process performs the functions of changing the data stored in the XML documents to internal scripting languages of simulation systems (through appropriately addressed references to the tags (nodes) using XPatch language). Practical verification of

developed method can be implemented using 4DScript language (Fig. 2), which is the internal programming language of the Enterprise Dynamics simulation system.

4. Conclusion

The concept of production planning support systems and simulation systems integration, implemented using the method of data-driven modelling has been presented in this paper,. The use of indirect data model in the data transformation process enables the use of various planning systems applied in existing enterprises (MRP, ERP, MES, ...) as a source of input data as well as the generation of simulation models for various commercial simulation systems existing on the market.

Until now, using the presented method, the process of systems integration with the Enterprise Dynamics and FlexSim simulation systems were successfully implemented. The further research will focus on the possibility of obtaining input data for data-driven modelling process from the various ERP and MES systems used by manufacturing enterprises.

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